CLAIMS:

What is claimed is:

1. A self-moisturizing polymer electrolyte membrane composition for use in a fuel cell, said composition comprising

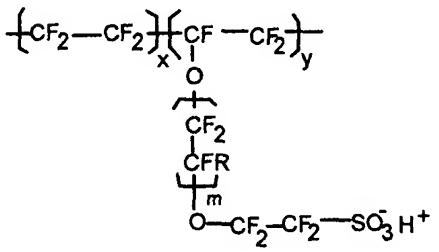
(a) a proton-conducting polymer comprising a detachable hydrogen ion and a counter-ion bonded to said polymer; and

(b) a deliquescent material for keeping said membrane wet and for detaching said hydrogen ion to facilitate proton transport in said membrane.

2. The membrane as defined in claim 1, wherein said deliquescent material is selected from the group consisting of zinc chloride, calcium chloride, magnesium chloride, lithium chloride, calcium bromide, potassium biphosphate, sodium formate, potassium acetate, phosphorous oxide, ammonium acetate, sodium acetate, sodium silicate, magnesium acetate, potassium silicate, magnesium sulfate, aluminum oxide, calcium oxide, silicon oxide, zeolite, barium oxide, cobalt chloride, bentonite, montmorillonite clay, silica gel, molecular sieve, monohydric compounds, polyhydric compounds, metal nitrate salt, sodium ethyl-sulfate organic salt, polyethylene glycol, polyvinyl pyrrollidone, and combinations thereof.

3. The membrane as defined in claim 1, wherein said proton-conducting polymer is selected from the group consisting of poly(perfluoro sulfonic acid), its chemical derivative, its copolymer, its blend with a second polymer, and combinations thereof.

4. The membrane as defined in claim 1, wherein said proton-conducting polymer is selected from the group represented by the formula:



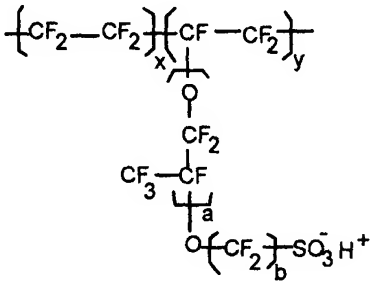
where x and y are integers selected from 1 to 100,000, m is an integer selected from 0 to 10 and R is a functional group selected from the group consisting of H, F, Cl, Br, I, and CH_3.

5. The membrane as defined in claim 1, wherein said proton-conducting polymer is characterized by comprising a structure having a substantially fluorinated backbone which has recurring pendant groups attached thereto and represented by the general formula:

$$--O(CFR_f')_b-(CFR_f)_a-SO_3H$$

where a = 0-3, b = 0-3, a+b = at least 1, R_f and R_f' are independently selected from the group consisting of a halogen and a substantially fluorinated alkyl group having one or more carbon atoms.

6. The membrane as defined in claim 1, wherein said proton-conducting polymer comprises a repeating unit represented by the following formula:



where **a** is 0, 1, or 2, **b** is 2 or 3, **x** and **y** are positive integer numbers and **x/y** ratio is of 10 or less.

7. A membrane/electrode assembly (MEA) comprising an anode, a cathode, and a polymer electrolyte membrane as defined in claim 1 and being interposed between said anode and said cathode, said anode and said cathode comprising electro-catalysts thereon or therein.

8. A self-moisturizing fuel cell comprising:

(a) a central polymer electrolyte membrane as defined in claim 1 for proton transport, said membrane comprising two opposite primary surfaces;

(b) two electro-catalyst layers on the two opposite sides of the electrolyte membrane in

which the chemical reactions occur;

(c) two gas diffusion electrodes stacked on said electro-catalyst layers, each gas diffusion electrode comprising an electronically conducting, porous material through which reactants and reaction products diffuse in and out of the cell; and

(d) two flow field plates stacked on said gas diffusion electrodes.

9. A self-moisturizing fuel cell comprising:

(a) a central polymer electrolyte membrane as defined in claim **2** for proton transport, said membrane comprising two opposite primary surfaces;

(b) two electro-catalyst layers on the two opposite sides of the electrolyte membrane in which the chemical reactions occur;

(c) two gas diffusion electrodes stacked on said electro-catalyst layers, each gas diffusion electrode comprising an electronically conducting, porous material through which reactants and reaction products diffuse in and out of the cell; and

(d) two flow field plates stacked on said gas diffusion electrodes.

10. A self-moisturizing fuel cell comprising:

(a) a central polymer electrolyte membrane as defined in claim **3** for proton transport, said membrane comprising two opposite primary surfaces;

(b) two electro-catalyst layers on the two opposite sides of the electrolyte membrane in which the chemical reactions occur;

(c) two gas diffusion electrodes stacked on said electro-catalyst layers, each gas diffusion electrode comprising an electronically conducting, porous material through which reactants and reaction products diffuse in and out of the cell; and

(d) two flow field plates stacked on said gas diffusion electrodes.

11. A self-moisturizing fuel cell comprising:

(a) a central polymer electrolyte membrane as defined in claim **4** for proton transport, said membrane comprising two opposite primary surfaces;

(b) two electro-catalyst layers on the two opposite sides of the electrolyte membrane in

which the chemical reactions occur;

(c) two gas diffusion electrodes stacked on said electro-catalyst layers, each gas diffusion electrode comprising an electronically conducting, porous material through which reactants and reaction products diffuse in and out of the cell; and

(d) two flow field plates stacked on said gas diffusion electrodes.

12. A self-moisturizing fuel cell comprising:

(a) a central polymer electrolyte membrane as defined in claim **5** for proton transport, said membrane comprising two opposite primary surfaces;

(b) two electro-catalyst layers on the two opposite sides of the electrolyte membrane in which the chemical reactions occur;

(c) two gas diffusion electrodes stacked on said electro-catalyst layers, each gas diffusion electrode comprising an electronically conducting, porous material through which reactants and reaction products diffuse in and out of the cell; and

(d) two flow field plates stacked on said gas diffusion electrodes.

13. A self-moisturizing fuel cell comprising:

(a) a central polymer electrolyte membrane as defined in claim **6** for proton transport, said membrane comprising two opposite primary surfaces;

(b) two electro-catalyst layers on the two opposite sides of the electrolyte membrane in which the chemical reactions occur;

(c) two gas diffusion electrodes stacked on said electro-catalyst layers, each gas diffusion electrode comprising an electronically conducting, porous material through which reactants and reaction products diffuse in and out of the cell; and

(d) two flow field plates stacked on said gas diffusion electrodes.

14. A self-humidifying fuel cell comprising:

(a) a central polymer electrolyte membrane layer for proton transport, said membrane having two opposite primary surfaces;

(b) two electro-catalyst layers on the two opposite sides of the polymer electrolyte

membrane in which the fuel cell electro-chemical reactions occur;

(c) two gas diffusion electrode layers stacked on said two electro-catalyst layers, each gas diffusion electrode comprising an electronically conducting, porous material through which reactants and reaction products diffuse in and out of the cell; and

(d) two flow field plate layers stacked on said gas diffusion electrodes;

wherein at least one of said membrane layer, electro-catalyst layers, gas diffusion layers, or flow field plate layers comprises a deliquescent material.

15. The fuel cell as defined in claim **14**, wherein at least two of said layers comprise a deliquescent material.

16. The fuel cell as defined in claim **14**, wherein said polymer electrolyte membrane comprises a deliquescent material.

17. The fuel cell as defined in claim **14**, wherein said deliquescent material is selected from the group consisting of zinc chloride, calcium chloride, magnesium chloride, lithium chloride, calcium bromide, potassium biphosphate, sodium formate, potassium acetate, phosphorous oxide, ammonium acetate, sodium acetate, sodium silicate, magnesium acetate, potassium silicate, magnesium sulfate, aluminum oxide, calcium oxide, silicon oxide, zeolite, barium oxide, cobalt chloride, bentonite, montmorillonite clay, silica gel, molecular sieve, monohydric compounds, polyhydric compounds, metal nitrate salt, sodium ethyl-sulfate organic salt, polyethylene glycol, polyvinyl pyrrollidone, and combinations thereof.

18. The fuel cell as defined in claim **14**, wherein said membrane polymer is selected from the group consisting of poly(perfluoro sulfonic acid), its chemical derivative, its copolymer, its blend with a second polymer, and combinations thereof.

19. The fuel cell as defined in claim **16**, wherein said deliquescent material is selected from the group consisting of zinc chloride, calcium chloride, magnesium chloride, lithium chloride, calcium bromide, potassium biphosphate, sodium formate, potassium acetate, phosphorous

oxide, ammonium acetate, sodium acetate, sodium silicate, magnesium acetate, potassium silicate, magnesium sulfate, aluminum oxide, calcium oxide, silicon oxide, zeolite, barium oxide, cobalt chloride, bentonite, montmorillonite clay, silica gel, molecular sieve, monohydric compounds, polyhydric compounds, metal nitrate salt, sodium ethyl-sulfate organic salt, polyethylene glycol, polyvinyl pyrrollidone, and combinations thereof.

20. The fuel cell as defined in claim **16**, wherein said membrane polymer is selected from the group consisting of poly(perfluoro sulfonic acid), its chemical derivative, its copolymer, its blend with a second polymer, and combinations thereof.

21. A self-moisturizing polymer electrolyte membrane composition for use in a fuel cell, said composition comprising

(a) a proton-conducting polymer capable of transporting hydrogen ion when a sufficient amount of moisture is present; and

(b) a deliquescent, hygroscopic, desiccant, water absorbent, or moisture exchange material for keeping said membrane wet to facilitate proton transport in said membrane.

22. A membrane/electrode assembly (MEA) comprising an anode, a cathode, and a polymer electrolyte membrane as defined in claim **21** and being interposed between said anode and said cathode, said anode and said cathode comprising electro-catalysts thereon or therein.

23. A self-moisturizing fuel cell comprising:

(a) a central polymer electrolyte membrane as defined in claim **21** for proton transport, said membrane comprising two opposite primary surfaces;

(b) two electro-catalyst layers on the two opposite sides of the electrolyte membrane in which the chemical reactions occur;

(c) two gas diffusion electrodes stacked on said electro-catalyst layers, each gas diffusion electrode comprising an electronically conducting, porous material through which reactants and reaction products diffuse in and out of the cell; and

(d) two flow field plates stacked on said gas diffusion electrodes.